Synopsis for Registration as Research Student

For

Doctoral Degree

On

Content Based Image Retrieval for Medical Applications

By

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1. Introduction

Images are used in medical field for diagnosis purpose. Medical imaging systems produce more and more digitized images in all medical fields: visible, ultrasound, X-ray tomography, MRI, nuclear imaging, etc. These images are related to the medical history of the patient. The Radiology Department of University of Geneva produced more than 12,000 images in a day. The Cardiology is second largest producer of digital images. Handling of the large database is too much difficult. There is necessity to go for content based image retrieval (CBIR) for supporting clinical decision making.

In CBIR, visual contents of images in database are extracted, described by multi-dimensional feature vectors. These feature vectors of images in the database form a feature database. To retrieve images, query image is provided to the system and is represented in terms of feature vectors. The similarity between feature vector of query image and those of images in the database are calculated. The block diagram of content based image retrieval system is shown in fig.1.

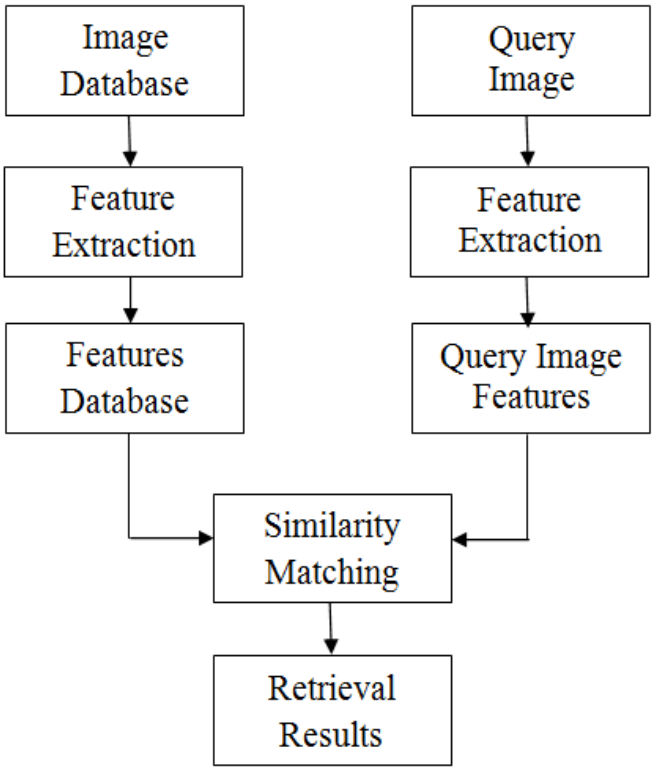

Fig. 1 Block diagram of content based image retrieval system

CBIR system can be used for retrieval of medical images associated with different diseases. Many diseases originate either in the eye, the brain or the cardiovascular system. The overview of most of the diseases that can be analysed using image analysis is as follows.

In Diabetes Mellitus there are high blood glucose levels for long period. It is due to pancreas not producing enough insulin. Hyperglycemia is due to increased blood glucose. It damages

small and large blood vessels as well as nerve cells. It also damages kidneys, heart, brain and eyes. Finally results complications of retina called as Diabetic Retinopathy (DR) [1].

Diabetic Retinopathy (DR) is damage to the retina due to diabetes. It affects up to 80% of patients who have diabetes for 20 years. It damages retinal blood vessels and leads to blindness. Different types of diabetic retinopathy are non-proliferative DR (NPDR), proliferative DR (PDR) and maculopathy or Macular Edema (ME). NPDR is earliest phase of DR and also called as background DR. Blood vessels in the retina become weakened. It creates a small, dot like Microaneurysm (MA) and Hemorrhages (H). In PDR, areas of retina become oxygen deprived. ME represents the swelling on the retina in central region.

Different signs of retinopathy [2] observed in the diabetic patient are shown in fig. 2.

Microaneurysms are weak dark red spots developed on blood vessels that bulge outward. These are first detectable change in the retina due to DR. Haemorrhage is oval or round shaped, formed by rupturing of Microaneurysm. These are dark red in colour and can be located within mid-retina. Hard exudates are deposits of protein in the retina. These are yellowish in colour. Cotton wool spots are soft exudates. These are white and fluppy lesions.

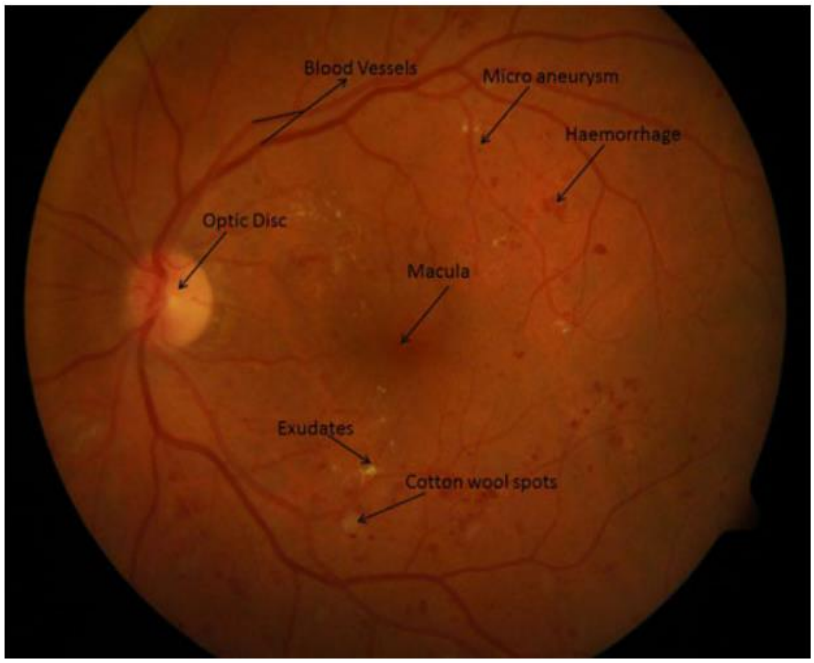

Fig. 2 Different signs of retinopathy observed in diabetic patient

Magnetic Resonance Imaging (MRI) is used to find tumour, bleeding, injury, blood vessel diseases. MRI uses a magnetic field and pulses of radio wave energy to make pictures of different parts inside the body. An MRI scan can be done for head, chest, blood vessels, abdomen and pelvis, bones, joints and spines.

MRI of head is done for detection of tumours and bleeding in the brain. MRI is also used to find problems of the eyes and optic nerves, the ears and auditory nerves. MRI of the chest may also be used to detect breast cancer. Problems like blocked blood vessels can be found

with the help of MRI of blood vessels. MRI can find problems in the organs and structures in the belly, such as the liver, pancreas, kidneys, and bladder. MRI can check for problems of the bones and joints, such as arthritis, bone marrow problems, bone tumours, cartilage problems. MRI is done more commonly than other tests to check for bone and joint problems. MRI is also used to check the discs and nerves of the spine for conditions such as spinal stenosis, disc bulges, and spinal tumours.

MRI images are shown in fig. 3

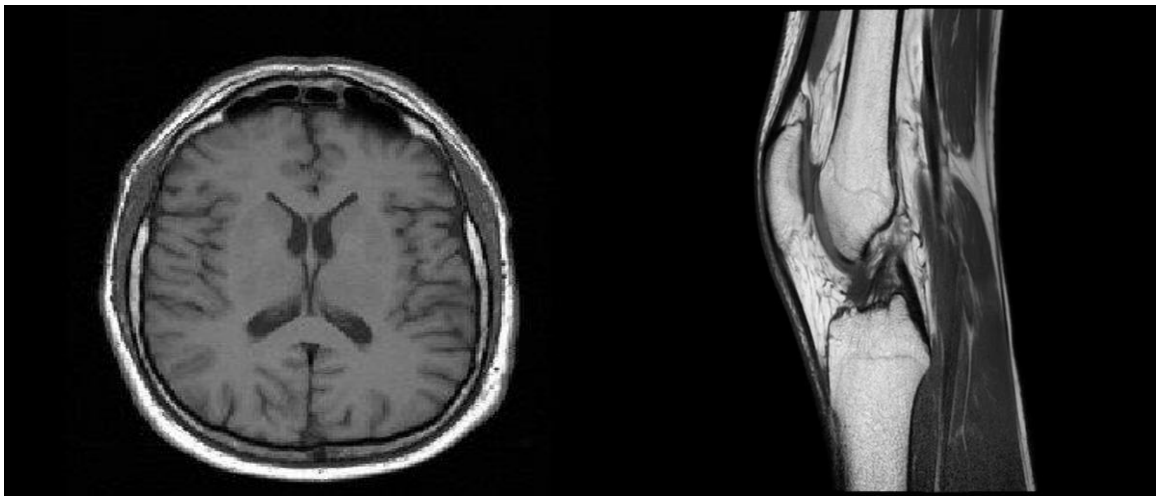

Fig. 3 MRI of Brain and Knee

Computed tomography (CT) is an imaging procedure which uses x-ray equipment to obtain detailed pictures of areas in the body. CT images of internal organs, bones, soft tissue and blood vessels provide greater detail as compared to traditional x-rays of soft tissues and blood vessels. CT imaging is used to evaluate different diseases such as Lymphoma, Neuroblastoma and Cystic fibrosis.

Lymphoma is the group of blood cell tumours developed from lymphatic cells. Neuroblastoma is a cancer that develops from immature nerve cells found in several areas of the body. It arises in and around the adrenal glands, also in other areas of abdomen, chest, and neck and near the spine. Cystic fibrosis is disorder that causes severe damage to the lungs and digestive system. It affects the cells that produce mucus, sweat and digestive juices. CT scan image is shown in fig. 4

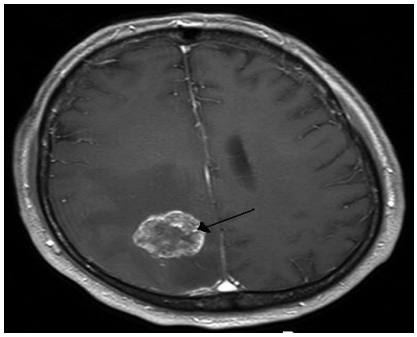

Fig. 4 CT scan image of brain with tumour

2. Motivation

Medical imaging refers to number of techniques that can be used as non-invasive methods. In the world, it is a need to diagnose, treat and cure patients without any side effects. Medical imaging has enabled doctors to see inside a patient. It also allows doctors to find disease earlier. Effective, safe and high quality medical imaging is must for correct diagnosis. Imaging for medical purposes involves a team of radiologists, radiographers (x-ray technologists), sonographers, biomedical engineers, etc. In the medical field, these images are produced in the large quantities and used for diagnostics and therapy. The Radiology Department of University of Geneva produced more than 12,000 images in a day. The Cardiology is second largest producer of digital images. The total amount of cardiologic image data produced in the Geneva University Hospital was around 1 TB in 2002 [3]. The management and access of this large database becomes complex. The goal of medical information system is to deliver the required information at the right time, the right place to the right person. This improves quality and efficiency of care processes. In clinical decision making process, it is important to find other images for a given query image of a disease. This is done by using content based image retrieval technique.

If retinal imaging is considered, the global prevalence of diabetes is 8.3 % in the year 2013 and it will increase up to 10.1 % by 2035. Moreover, 382 million people are living with diabetes worldwide, and it may increase up to 471 million by the year 2035. Long term and uncontrolled diabetes damages the vital organs, namely heart, kidneys, feet, and also affects the blood vessels in the human retina causing diabetic retinopathy (DR). There is a need for implementing various techniques for diagnosis of retinal diseases. Content-based image retrieval (CBIR) can play a significant role in assisting the diagnosis of retinal diseases in communities with lack of experienced ophthalmologists. If MRI and CT scan imaging is considered, diseases like tumors, blocked blood vessels can be detected. CBIR can also be used for diagnosis of MRI and CT scan images. As the database of medical images is large, content based image retrieval technique can be used for retrieval of images which are similar to given query image.

3. Literature Survey

CBIR is an active area of research since last 10 years. The term CBIR was used by T. Kato in 1992. Automatic retrieval of images from a database was done with the help of colour and shape features. CBIR system was developed initially by IBM. It was called as Query by image content. After that CBIR system was developed for medical applications. The brief overview of algorithms is described below.

K. Yuan *et al.* [4] developed the Brain CT image database for computer aided diagnosis using content based image retrieval. Medical images were obtained and then image processing algorithms such as image normalization and registration were applied. Non-negative tensor factorization was used for extraction of features. B. Prasad and A. Krishna [5] implemented CBIR system based on proper use of texture information within the images. Methods implemented were: Haralick Statistical Co-occurrence Matrix and Tamura method. Hash

structure was used for extraction and indexing of features. For similarity measurement Euclidean distance measure was used. Tamura features gave better retrieval results for brain CT scan images.

S. Murala and Q. Jonathan Wu [6] proposed local mesh peak valley edge pattern for biomedical image indexing and retrieval. The method extracts gray scale relationship among the neighbours for a given center pixel in an image. The database considered was OASIS MRI database which is the magnetic resonance imaging (MRI) database and VIA/I–ELCA P-CT database. C. Baby and D. Chandy [7] proposed content based retinal image retrieval technique using dual tree complex wavelet transform (DT-CWT). They used combination of two dimensional DT-CWT and generalized Gaussian density for feature extraction. For calculating similarity measure between two feature set Kull back Leibler Divergence is used. MESSIDOR database was used as experimental data.

J. Sivakamasundari *et al.* [8] developed Content Based Image Retrieval (CBIR) framework based on edge detection method for diagnosis of diabetic retinopathy. The edge information was enhanced by applying pre-processing images to normal and abnormal retinal fundus images. For segmentation of blood vessels Kirsch template and Canny edge based detection techniques are used. Features obtained from segmented images were used for analysis. Euclidean distance method was applied for similarity matching. S. Murala and Q. Jonathan Wu [9] proposed a feature extraction algorithm called local ternary co-occurrence patterns for biomedical image retrieval. They used combination of proposed algorithm with the Gabor transform. The algorithm was used for computer tomography (CT) and magnetic resonance image retrieval. The database considered was OASIS − MRI database, NEMA− CT database and VIA/I–ELCAP database.

P. Srivastava *et al.* [10] proposed a method for content based image retrieval using moments of Local Ternary pattern (LTP).In this, they divided an image into blocks of equal size and LTP codes of each block were computed. Later, geometric moments of LTP codes were used as features for computation of distance between moments of LTP codes of query and database images. Corel 1000 database was used for performance analysis. A. Faria *et al.* [11] used CBIR as an image searching engine and population based analysis to utilize past clinical data for future diagnosis. They used MRI images as a database. F. Abdolali *et al.* [12] presented medical content based image retrieval for dataset containing maxillofacial lesions. They extracted features based on sparse coding and maximum pooling. Similarity measures such as Euclidean norm, Manhattan distance and SVM classifier were used to select most relevant images to the query image.

A. Kumar *et al.* [13] used content based image retrieval techniques for the semantic annotation of medical images. They extended CBIR methods to annotate liver CT images. I. Kitanovski *et al.* [14] implemented a system for medical image retrieval. The method was based on textual and visual content, using advanced encoding and quantization techniques. A Gaussian mixture model was constructed for extracted visual features such as RGB histograms. For evaluation of the system Standardized Image CLEF 2013, 2012 and 2011

medical datasets were used. In [15-17] content based medical image retrieval systems were developed for different medical applications.

4. Identified open Research Problems

Medical imaging is rapidly evolving area of research. The research is going in different areas such as:

1) Develop an automated screening system for diagnosis of diseases such as age related molecular degeneration, diabetic retinopathy, macular degeneration, glaucoma, etc.
2) Fast and accurate algorithms for detection of retinal structures such as retinal vessels, optic disc and fovea
3) Tumour detection using MRI and CT scan images of different body parts

5. Problem Definition

Looking at rapid progress and journey of medical imaging, problems can be defined as:

1) As the amount of data to be analysed is large, computerized interpretation of images is necessary.
2) If diagnosis is complex for human expert, there is a need of automated medical imaging systems.

6. Future Research Plan

1) To develop feature extraction techniques for CBIR so that the burden of ophthalmologists can be reduced (for diagnosis of retinal diseases).
2) To combine statistically significant features obtained by different CBIR techniques in order to get improved retrieval accuracy.
3) To use content based image retrieval algorithms for diagnosis of CT scans and MRI images so that clinical decision making will be easier.

7. Proposed Work Plan

Sr. No.	**Phase**	**Details of work to be carried out**
1	I	Literature Survey, Problem Formulation and Synopsis Write up. Course work completion and implementation of already developed algorithms.
2	II	Collection of medical data and its use to check performance of the algorithms. Modification in the previous techniques for improving accuracy.
3	III	Development of new feature extraction techniques for CBIR so that accurate retrieval and diagnosis of medical images take place.

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